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Environmental Resources Document for Wallops Flight Center

December 1980

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DOCUMENT FOR WALLOPS FLIGHT CENTER (NASA)
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National Aeronautics and
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Wallops Flight Center
Wallops Island, Virginia 23337
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ENVIRONMENTAL RESOURCES DOCUMENT

FOR

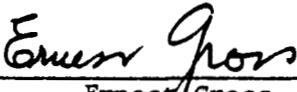
WALLOPS FLIGHT CENTER

National Aeronautics and
Space Administration
Wallops Flight Center
Wallops Island, VA 23337

DECEMBER 1980

WALLOPS FLIGHT CENTER
ENVIRONMENTAL RESOURCES DOCUMENT

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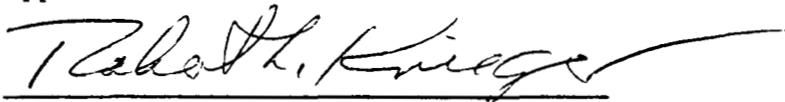
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1. FOREWORD

This Environmental Resources Document supersedes and updates the original Wallops Flight Center (WFC) Environmental Impact Statement of February 1972. The document was prepared in conformity with the National Environmental Policy Act and NHB 8800.11 Implementing the National Environmental Policy Act. It consolidates and brings up to date the evaluations of environmental effects associated with current and future activities at the Center. As a fully revised institutional and programmatic statement for WFC, the Environmental Resources Document includes consideration of the site, specific environmental effects of all development, and operations activities at WFC. The Resources Document shows that all current and anticipated activities at WFC have no significant or harmful impact on the environment.

2. WALLOPS FLIGHT CENTER (WFC)

a. Description

WFC is located in Accomack County, Virginia, on the Atlantic Coast of the Delmarva Peninsula, approximately 40 miles southeast of Salisbury, Maryland, and 70 miles north of the Chesapeake Bay Bridge Tunnel (Figure 1).

WFC is the only flight test facility wholly owned and operated by the National Aeronautics and Space Administration (NASA).

The Center is a complex of three separate land areas - the Main Base, Wallops Island, and Wallops Mainland (Figure 2). The Center area is 6,612 acres of which 3,950 are woodland and brush; 1,140 are tidal marshland; 37.09 leased for farming; and the remainder is occupied by Center facilities.

The Main Base, containing 2,230 acres, is bordered on the east by four miles of marshland which separates it from Chincoteague Island. The Main Base contains the WFC headquarters, some tracking facilities, a range control center, rocket and fuel storage depots, rocket vehicle inspection facilities, several support shops, office buildings, and the only NASA owned airfield.

Wallops Island and Wallops Mainland jointly comprise a land area of 4,331 acres and are located approximately seven miles southeast of the Main Base. Wallops Island, a barrier island, is connected to Wallops Mainland by a causeway and bridge over two miles of salt marsh and Cat Creek, an inland waterway.

Wallops Island is approximately five miles long and a half mile wide at its widest point. It contains launch sites, blockhouses, rocket storage buildings, assembly shops, dynamic balancing facilities, tracking facilities, and other related support facilities.

About half of the Island is salt marsh, a fifth sand and beach, a fifth developed, and the remainder is covered with shrubs and trees.

Wallops Mainland, a strip of land of approximately 100 acres, is located two miles west of the Island. It provides a site for long-range radar, communications, and optical tracking installations.

b. Mission

The mission of WFC is to:

1. Plan and conduct launches of scientific satellites, sounding rockets, test vehicles, and other payloads as requested by other NASA elements and the world scientific community.
2. Provide personnel and facilities for conducting research tests of various aircraft and helicopters in the terminal area operating environment.

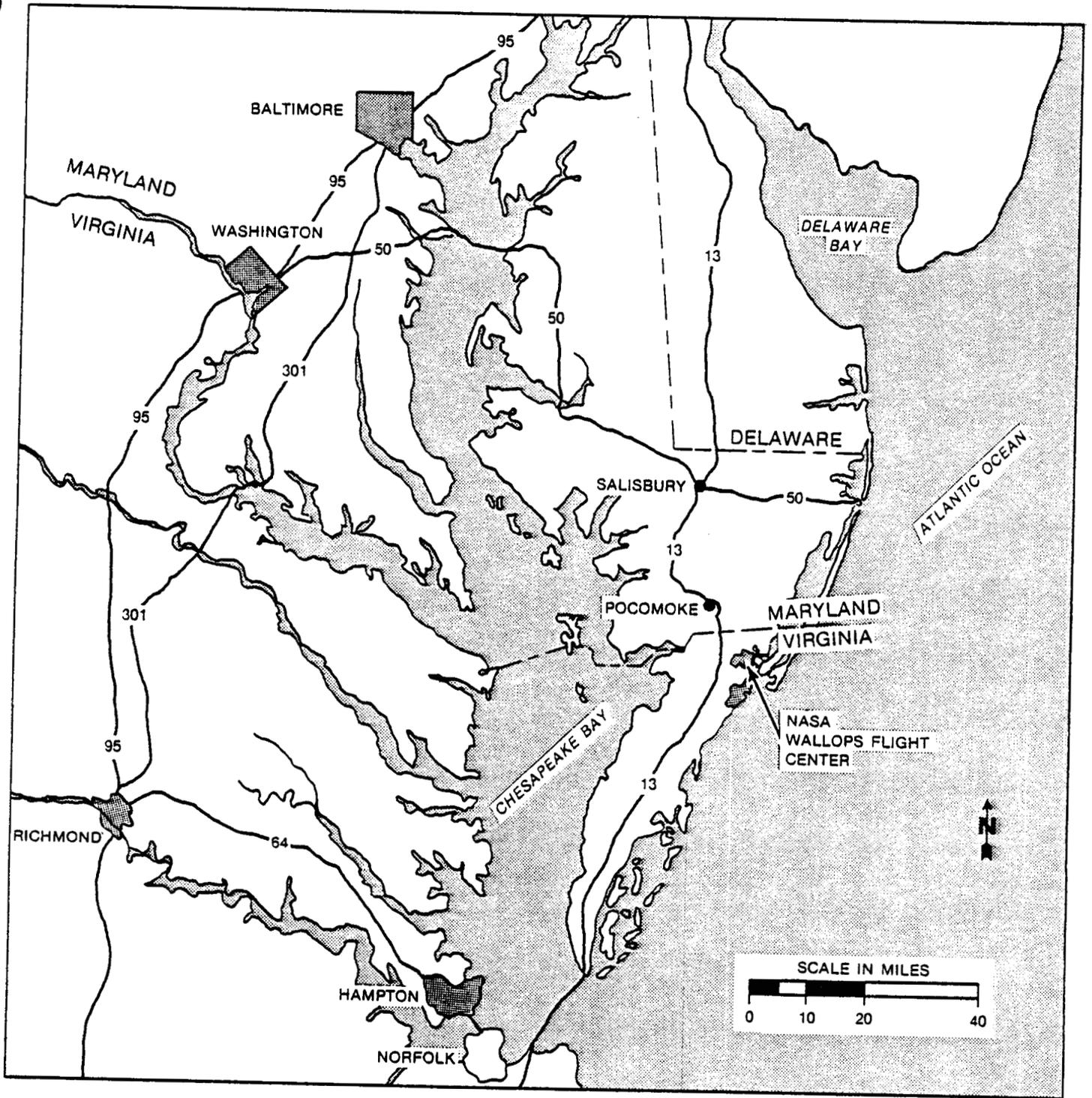


Figure 1

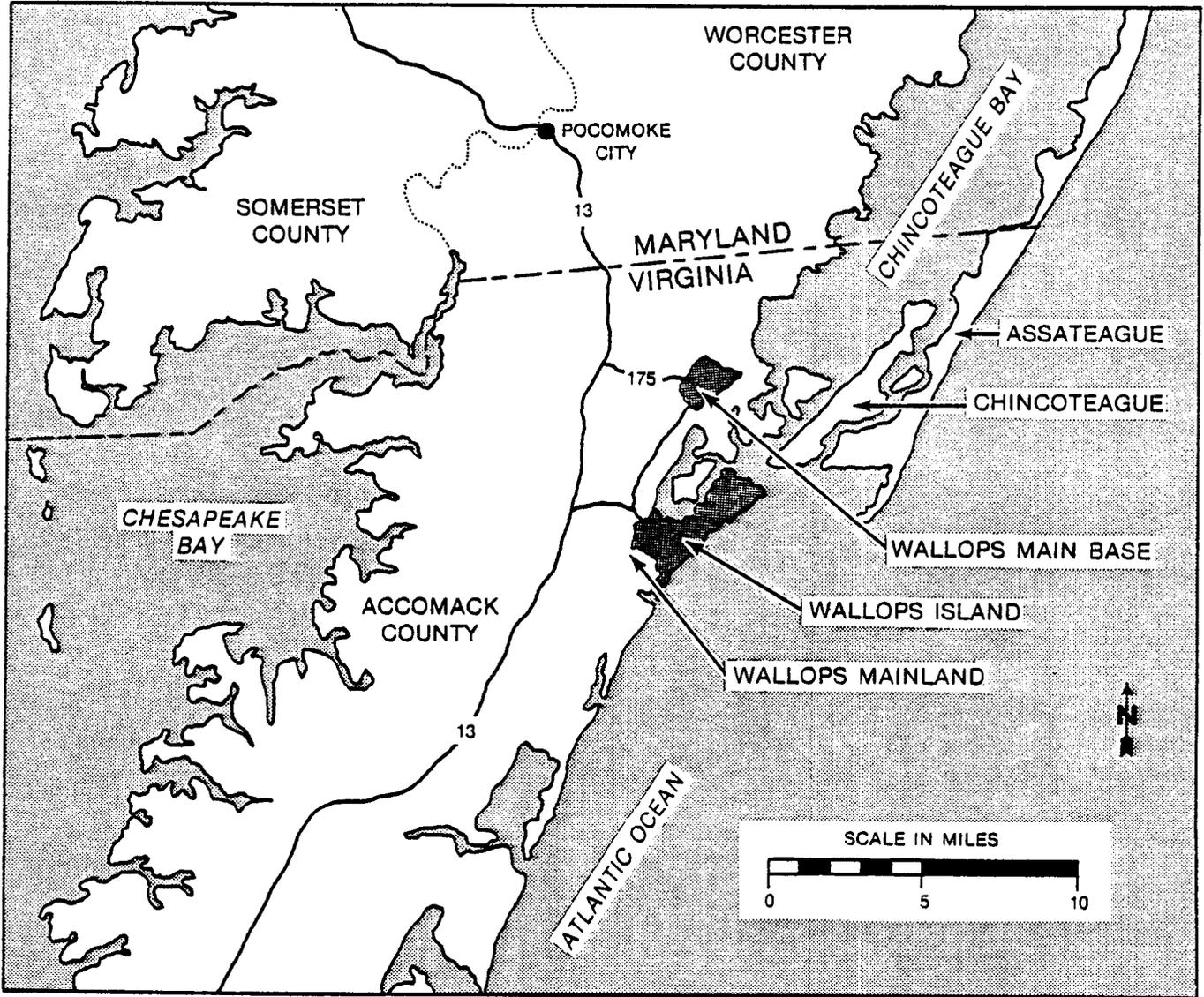


Figure 2

3. Develop, operate, and maintain supporting instrumentation, tracking and data acquisition facilities for use in the conducting of tests.
4. Plan, develop, operate, maintain necessary launch techniques and operations, collect flight test data, and other phases of launch support.
5. Perform tracking and data acquisition support for spacecraft and payloads launched at other test facilities.
6. Provide project management for aerospace programs as requested by NASA Headquarters.
7. Provide administrative and management support for assigned programs as delegated by NASA Headquarters.

c. Future Missions

WFC will continue to launch 250-300 rockets a year and will continue conducting research experiments on the airfield covering such areas as aviation testing, atmospheric sampling, oceanography studies, and aircraft noise measurement studies.

The U. S. Naval Surface Weapons Center is proposing to set up an AEGIS Combat System Center on Wallops Island.

On-going action consists of installing portions of the MK 86 Gun Fire Control System (a component of the Nuclear Powered Guided Missile Cruiser CGN 38 Combat System) in Building Z-41.

Operations are expected to begin in 1981 using radar against numerous targets to establish a data base; then specific targets will be scheduled to study the system's behavior.

The U. S. Naval Surface Weapons Center has written an Environmental Assessment pertaining to their planned operations. This is listed in the bibliography.

d. Physical Structures

The basis for WFC's present success and future potential is based on its flexibility and its ability to accommodate a wide range of researchers and programs. The goal, as described in its Master Plan, is to keep the present plant at the proper level of operational effectiveness through continued maintenance of utilities and facilities and the renovation of needed buildings. This will provide a plant generally capable of supporting varying types of programs.

In the past, it has been the policy to use all available existing structures to their greatest advantage because of immediate needs and economic considerations. Site arrangements and functional groupings have been generally well organized.

At the Main Base there is an administrative core with aircraft operations directly to the north and space operations to the south. Storage areas are well grouped and can be expanded; expandable service facilities include the various shops and utility systems.

The Mainland and Island have concentrated on operations dealing with launches and launch support operations, thereby requiring only essential storage, service, and administrative facilities. Some of the major structures among the many buildings, shops, and storage facilities at the WFC are:

A-1 Aircraft Control Tower.
B-129 Damage Control.
D-1 Aircraft hangar storage and office space.
D-4 Water pumping station.
D-8 Central heating plant.
D-10 Auditorium and post office.
D-12 through D-12J; D-97 through D-100 - Sewage treatment plant facilities.
D-47 Water storage tank.
D-95 Water Plant.
E-2 Cafeteria and photo laboratory.
E-104 Employee Development Center.
E-105 Technical library and office building.
E-106 Office building.
E-107 Procurement and fiscal office building.
E-108 Range engineering building.
F-1 Administrative office building.
F-2 Management services and reproduction building.
F-6 WFC headquarters building.
F-7 Shipping and receiving building.
F-10 Technical service area.
F-20 Automotive repair; utilities maintenance shop.
F-21 Carpentry and electrical shop.
F-160 Calibration and chemistry labs; dispensary.
M-2 through M-14 - Underground magazines.
M-15 through M-16 - Rocket inspection; storage shelters.
M-20 Rocket storage building.
N-159 Range control; evaluation facilities building.
N-161 Special projects building.
N-162 Communications and receiving.
NOAA - Command and Data Acquisition Station.
U-25 RARF radar building.
U-30 NASA long-range radar.
U-55 Transmitter building.
U-70 AN/FPQ 6 c-band radar.
V-50 Dynamic balancing facility.
W-15, W-40, W-55, W-65 - Assembly shops.
W-20 Blockhouse #3.
X-15 Dehumidified storage.
X-35 Damage control; service shops.
X-55 General service building.
X-85 Meteorological facility.

Y-15 Model assembly shop #1.
Y-30 Blockhouse #2.
Y-55 FPS-16 c-band radar.
Y-60 Island radar control building.

Another project action is the construction of a new WFC visitor center building. A \$242,000 contract has been awarded for construction of the building on Route 175, adjacent to the WFC airport. The 70 ft. x 92 ft. one story building will provide an educational facility for school children and many visitors. The structure, expected to be ready by spring 1981, will contain a theater for movies and lectures and also space for exhibits.

Also, a 1.1 million dollar Facility Operations Shop building is under construction at WFC.

e. History

The recorded history of Accomack County dates from the early 1600's. On June 2, 1608, Capt. John Smith and 17 men set out from Jamestown, Virginia, to explore the Chesapeake Bay and many of the islands of the lower Eastern Shore.

In 1672 a patent was issued to John Wallop for 1,450 acres, being "all Keekotank Island alias Accocomson Island." In 1693 John Wallop devised "my Island formerly called Keekotank Island" to two of his children. From that time on the property was known as Wallops Island.

The property was owned by the family and heirs until it became the property of the Wallops Island Association, which in 1889 paid \$8,000 for controlling interest and spent another \$7,000 for a clubhouse. In 1933 the Wallops Island Club, a gun and fishing club, was incorporated and took title in its own name.

The United States Government, through the National Advisory Committee for Aeronautics (NACA), the predecessor agency of NASA, took over the Island in 1945. The U. S. District Court set the cost at \$93,258.71. Much of the Wallops Main Base property also came down through the Wallop family with patents in 1664 of nearly 3,000 acres. It was taken over in World War II for a Naval Air Station. The Main Base facilities, formerly known as the Chincoteague Naval Air Station, were constructed between 1941 and 1958. In 1959 the Navy closed the station, and NASA acquired all of the Main Base, and in the same year, acquired the Mainland site property. In 1945 a launch facility was constructed on Wallops Island by NACA as an auxiliary base of the NASA Langley Field, Virginia.

3. AIR RESOURCES

a. Climate

The climate at WFC is humid temperate with no distinct dry season. The relative humidity averages 76 percent. Spring is the season of lowest

humidity, with an average of 71 percent in March. Late summer and fall are the most humid with an average of 78 to 79 percent from August through October. The daily averages vary from a maximum of 83 percent in the early morning to 66 percent in the afternoon. Surface winds are predominantly westerly or northwesterly in winter and southerly or southeasterly in the summer. The average wind velocity is 9 to 10 miles per hour in summer and 11 to 13 in the winter. A sea breeze with the wind shifting to southeasterly occurs frequently in the late morning hours in spring and early summer. It occurs occasionally in fall and may occur on warmer days in early afternoon. Calm winds occur mostly at night and average 5 percent of the observations in mid-summer and 2 percent in the spring. Visibility of 1 mile or less occurs 4 percent of the time and 6 miles or less 26 percent of the time. Haze causes about one half of the obstructions to vision of less than 7 miles and fog or precipitation the rest.

TEMPERATURE

	<u>Daily Averages 1941-1970</u>		<u>Record Temperatures 1951-1980</u>	
January	44	29	74	- 4
February	45	30	77	- 4
March	52	36	82	16
April	62	46	89	24
May	71	55	96	33
June	79	64	97	40
July	83	69	100	51
August	82	68	101	50
September	78	62	93	40
October	68	52	89	22
November	57	41	84	18
December	47	31	76	4

PRECIPITATION*

	<u>Average Monthly</u>	<u>No. of Days</u>	<u>Driest</u>	<u>Wettest</u>
January	2.7	10	1.6	6.8
February	2.8	9	0.8	6.1
March	2.8	11	1.1	6.8
April	3.4	10	0.5	3.8
May	3.0	10	0.8	7.8
June	2.7	8	0.1	5.5
July	3.9	9	0.6	6.6
August	2.8	8	1.0	10.0
September	2.6	8	1.1	6.4
October	2.7	7	0.5	6.1
November	2.7	9	0.4	5.4
December	2.7	9	0.8	9.4

* Incomplete record 1946 through June 1980 with 29 or more values each month.

Snow occurs during some winters, usually January to mid-March, but winters without snow are not rare.

b. Air Quality Standards

Possible environmental effects on air quality from WFC operations include automotive vehicle emissions, waste products of fuel combustion by utilities, exhaust effluents from space vehicle launches, and chemical releases by venting and evaporation. Altitude and upper atmospheric winds disperse and diffuse these emissions.

WFC maintains a responsible attitude in controlling pollutants and cooperates with civil authorities or concerned individuals to help control any activities which would have an adverse effect on total, local, or individual environments.

Launch operations are conducted at the edge of and towards the open sea. The limiting conditions imposed by range safety restrictions, such as dispersion parameters, wind velocities, range surveillance, and exacting safety procedures which must be followed, are all factors which reduce adverse effects to the environment and surrounding community.

Prior to acceptance of experiments to be launched at Wallops, program plans must contain an analysis and documentation of potential atmospheric or ocean contamination. Regular measurements and reporting of emissions of hazardous air pollutants at Wallops are measured against federal and Virginia state standards which are identical.

The air quality standards are as follows:

AIR QUALITY STANDARDS

<u>Pollutant</u>	<u>Primary*</u>	<u>Secondary*</u>
Particulate matter (micrograms/cubic meter)		
Annual (2)	75	60
4-hour	60	150
Sulfur dioxide (micrograms/cubic meter)		
Annual (3)	80 (0.03) (1)	
24-hour	365 (0.14)	
3-hour		1300 (0.5)
Carbon monoxide (milligram/cubic meter)		
8-hour (4)	10 (9)	10 (9)
3-hour	40 (35)	40 (35)
Photochemical oxidants (ozone) (micrograms/ cubic meter)		
1-hour	240 (0.12)	240 (0.12)
Nonmethane hydrocarbons (methane) (micro- grams/cubic meter)		
6-9 a.m.	160 (0.24)	160 (0.24)
Nitrogen dioxide (micrograms/cubic meter)		
Annual (3)	100 (0.05)	100 (0.05)

*The primary standard is an interim standard which allows an adequate margin of safety to protect the public health. The secondary standard will eventually be the minimum for all communities and is designed to protect the public from any known or anticipated effects.

- (1) Concentrations in parentheses are in parts per million.
- (2) Calculated as the geometric mean.
- (3) Calculated as the arithmetic mean.
- (4) Concentrations specified for averaging times of 24 hours or less are not to be exceeded more than once a year.

c. Air Quality Conditions

Air quality measurements of particulates are currently monitored at two Accomack County stations - the Health Department in Accomac and at Wallops Island. The 1977 geometric mean at the Health Department station was 37 micrograms per cubic meter, and at Wallops it was 53 - both below the secondary standard of 60.

Although other pollutants are not measured, the State Air Pollution Board judges these levels to be within the accepted standards. Unpublished results of a study of nitric oxide (NO) emission at peak periods (early afternoon) at Wallops showed 35 parts per trillion against a standard of 50 parts per billion. Unpublished results of a study of sulfur dioxide (SO₂) at WFC by Dr. Alan R. Bandy of Drexel University showed a maximum of seven to eight parts per billion or a mean of 500 parts per trillion. Other studies showed below standard emission levels of carbonyl sulfide (OCS) - 31 parts per trillion; dimethyl sulfide (CS₂) - 58 parts per trillion; hydrogen sulfide (H₂S), with a mean of several parts per trillion. Studies of ozone, however, showed that on certain summer afternoons in 1977, the mean ozone concentration at the Center exceeded the then standard of 0.08 parts per trillion. These emission rates prevail in the entire region, and are due in some measure to the synthesization of such natural precursors as urban air and emanations from the forests.

The 1977 study by the Virginia State Air Pollution Control Board was conducted in the Wallops and Tidewater areas and adjoining North Carolina. Readings of ozone concentrations showed the average peak at Wallops was well above 0.085 parts per million, mostly between 1 p.m. and 4 p.m. The majority of the peak ozone levels are due to photochemical activity, but some concentrations result from vertical and horizontal transport.

Ozone concentrations are affected significantly by the sea breeze circulation at Wallops. Although high ozone levels occurred with all wind directions at WFC, somewhat higher ozone levels occurred with southeast and westerly winds. A slight drop in concentrations occurred with winds from the south and southwest. High ozone levels were found to occur with both high and low wind speeds. Ozone may be synthesized in the troposphere from natural precursors, and ozone and/or its precursors may be advected into the area from neighboring regions.

Additional studies of emissions of dimethyl sulfide, carbonyl sulfide, hydrogen sulfide, nitric oxide, and sulfur dioxide are being planned for the marshes of Wallops Island.

WFC used 1,213,000 gallons of No. 6 heating oil with a sulfur content of approximately 2 percent in 1979. Reduction of the sulfur content had been planned in 1972 but was not implemented when the state of Maryland granted a waiver on the sulfur content. The state of Virginia had not required a lower sulfur content.

The five boilers operating at the Center are permitted a total of 37 pounds of particulate emissions per hour by the State Air Pollution Control Board, and the emissions are significantly below that level.

The Main Base heating plant is about 25 years old, but it has undergone extensive renovation of the building and equipment. The central part of the Island has a central steam distribution system with two 150 HP boilers. Buildings requiring heat and hot water on the north and south ends of the Island and on the Mainland are served by small individual systems.

Approximately 80,000 pounds of rocket motor fuel pollutants were expended into the upper atmosphere in 1979, compared with about 172,000 pounds in 1970. There were 274 rocket launches in 1979, compared with 601 in 1970. The pollutants included:

<u>Constituents</u>	<u>Pounds 1970</u>	<u>Pounds 1979</u>
Aluminum monochloride ion	43	20
Aluminum dichloride ion	30	14
Aluminum oxide	31,594	14,659
Carbon	2	1
Methane	2	1
Carbon monoxide	61,843	28,694
Carbon dioxide	20,238	9,390
Atomic chlorine	119	55
Carbon oxysulfide	9	4
Copper	92	43
Iron oxide	23	11
Monoatomic hydrogen	100	46
Diatomic hydrogen	3,450	1,601
Hydrogen chloride	18,425	8,549
Hydrogen fluoride	51	23
Water	16,941	7,860
Hydrogen sulfide	148	69
Hydrogen sulfide ion	3	1
Hydrogen disulfide ion	19	9
Potassium chloride	11	5
Potassium	1	1
Potassium hydroxide	6	3
Monoatomic nitrogen	2,299	1,067
Diatomic nitrogen	15,767	7,316
Ammonia	1	1
Hydroxyl radical	10	5
Lead	67	31
Sulfur	67	31
Diatomic sulfur	173	80
Sulfur dioxide	887	412
TOTAL	172,421	80,002

4. WATER RESOURCES

a. Ground and Surface Water

There are no major perennial running streams on Virginia's Eastern Shore. There is a limited amount of available ground water, and this is dependent upon precipitation for resupply. The Virginia State Water Control Board has indicated that its testing showed present ground water supplies are not being overdrawn, and there is no significant organic ground water contamination to the artesian aquifers below a depth of about 80 feet, as substantiated by low nitrate levels.

The WFC Main Base has seven deep wells, and the Wallops Mainland and the Island have two. Some of the wells are as deep as 228 feet, but the average depth is 65 feet.

The Main Base wells furnish an average of 119,000 gallons a day, while the two Mainland/Island wells provide an average of 11,150 gallons. This water is used for drinking, sanitary purposes, and fire protection. The pumped water is stored in a 100,000 gallon elevated tank and a 450,000 gallon ground level reservoir.

The deep wells tap the Columbia aquifer of the Pleistocene strata. A test well casing drilled in 1948 at the request of the U. S. Geological Survey has been used to measure the water table levels in the aquifer. The water table has remained stable since measuring began. The water is purified by the use of aeration, chlorination, the use of calcium carbonate to raise the pH factor, and the addition of phosphates. Tests are made daily of the pH and chlorine factors and occasionally for hardness. Monthly tests are made by the Accomack County Health Department for bacteria content. All tests are conducted in conformity with Virginia State Public Health regulations and requirements. The future use of water is not expected to increase significantly, and none of the operations resulting in waste water are expected to exceed state and federal standards.

b. Water Quality

The WFC sewage treatment plan originally was constructed for the predecessor Naval base in the 1940's to accommodate 5,000 persons. The current operation of the plant is geared to usage by about 800 people. The plant capacity is adequate to serve the needs of WFC in the foreseeable future. A recent monthly discharge monitoring report (May 1 to June 1, 1980) showed an average pollutant flow of .034 million gallons per day, when 0.3 million gallons are permitted by federal and state standards. The report also showed an average discharge of biochemical oxygen demanding (BOD) of 1.66 kilograms per day, when 34.0 is permitted; an average discharge of 1.28 kilograms per day of total suspended solids (TSS), when 34.0 is permitted, and a pH range of 6.1 to 7.0, when 6.0 to 8.5 is permitted.

There are no water polluting sources of any major consequence at the Wallops Center. The main sources of pollution are the Photo Lab and the Electroplating Shop. All the silver discharged from the Photo Lab operations is withdrawn from the discharge, stored, and reused. The discharge of the Electroplating Shop operations is so diluted by the time it reaches Mosquito Creek to the north that it does no damage to fish and other marine life in the receiving stream. These values are checked periodically by a qualified analyst. Control techniques are in conformity with the National Pollutant Discharge Elimination System Permit (#0024457).

Storm water drainage at the Main Base is accomplished by side ditches and swales along the streets where there are no curbs and gutters, drop inlets on curbed streets, and necessary culverts draining to natural waterways. The runoff is to Mosquito Creek on the north and west, and to Simoneaston Bay on the south and east. The airfield is graded to drain into drop inlets. The Mainland storm drainage is generally handled by overland flow to Chincoteague Bay. Storm drainage on Wallops Island is handled by cross culverts on the north-south road and by ditches to three storm water lift pump stations along the east side of the bypass road.

5. LAND RESOURCES

Topography, Geology, Soils

The Eastern Shore of Virginia is nearly flat with a low elevation, with 95 percent of the area having less than a 2 percent slope, and is interlaced by saline bays and tidal creeks. The maximum elevation in Accomack County is approximately 50 feet above mean sea level.

Geologically, the entire Eastern Shore is not very old - less than one million years. The present shape was created when the glaciers melted and boulders and detritus from the Susquehanna River built up a great shoal next to what was to become the Chesapeake Bay, the drowned valley of the Susquehanna. Wallops Island is located in the Coastal Plain while the Main Base is located on the Chowan Terrace (Figure 3).

The soils are deposits of marine origin consisting of about 36 to 40 inches of sandy clay, underlain by sand to depths of about 4,500 feet (Figure 4). Below that are igneous and metamorphic rocks ranging in depths to 7,500 feet in the northeast portion of Accomack County.

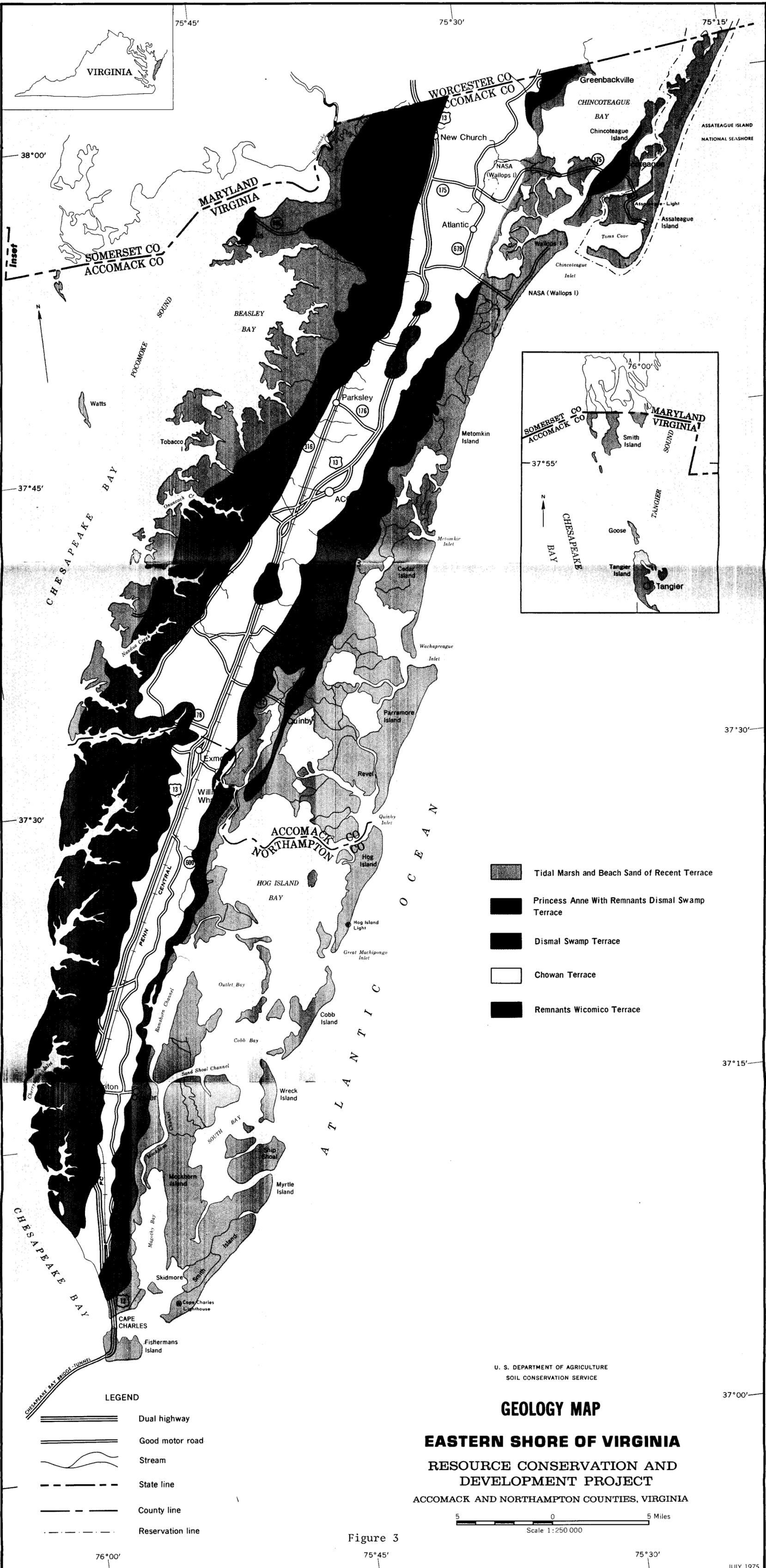
There has never been a detailed comprehensive soil survey for the entire county, but a recent Accomack-Northampton planning study included a general soil map for the Eastern Shore (Figure 5), prepared by the Soil Conservation Service of the U. S. Department of Agriculture. The dominant soils of the Eastern Shore are very sandy, resulting in their being highly-leached, acid, and usually low in natural plant nutrients. Soils of the Wallops area include:

Soil Association #1: State-Altavista-Psamments - State: Well-drained, nearly level to gently sloping, with a good potential for farming, urban uses, forestry, and recreation. Altavista: Moderately well drained, nearly level to gently sloping, with a good potential for farming, urban uses, forestry, and recreation, but with some limitations because of seasonally high water table. Psamments: Excessively well drained on low marine terraces, sloping to steep, sandy and droughty, with a potential for woodland and wildlife habitat.

Soil Association #4: Newhan Association - Excessively drained, deep soils on sand dunes. The soils are loose, sandy, and droughty, with little or no potential for farming or urban uses. There is a potential for adapted grasses and shrubs for erosion control and wildlife habitat. It needs careful management to maintain a good protective vegetative cover.

Soil Association #5: Beaches Association - Sandy beaches on the seaward side, subject to daily tidal flooding, with a good potential for recreational uses and a good food source for certain kinds of marine and bird wildlife.

Soil Association #6: Sulfaquents Association - Tidal marshes that have a high sulfur content, which are either silty and clayey or sandy. They are subject to daily tidal flooding. This is a highly-valuable resource as it provides a vital link in the food chain for most marine organisms and provides shelter and breeding grounds for many kinds of marine organisms.



- Tidal Marsh and Beach Sand of Recent Terrace
- Princess Anne With Remnants Dismal Swamp Terrace
- Dismal Swamp Terrace
- Chowan Terrace
- Remnants Wicomico Terrace

LEGEND

- Dual highway
- Good motor road
- Stream
- State line
- County line
- Reservation line

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

GEOLOGY MAP

EASTERN SHORE OF VIRGINIA
RESOURCE CONSERVATION AND DEVELOPMENT PROJECT
 ACCOMACK AND NORTHAMPTON COUNTIES, VIRGINIA

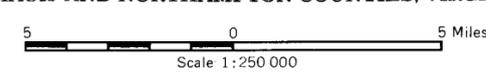
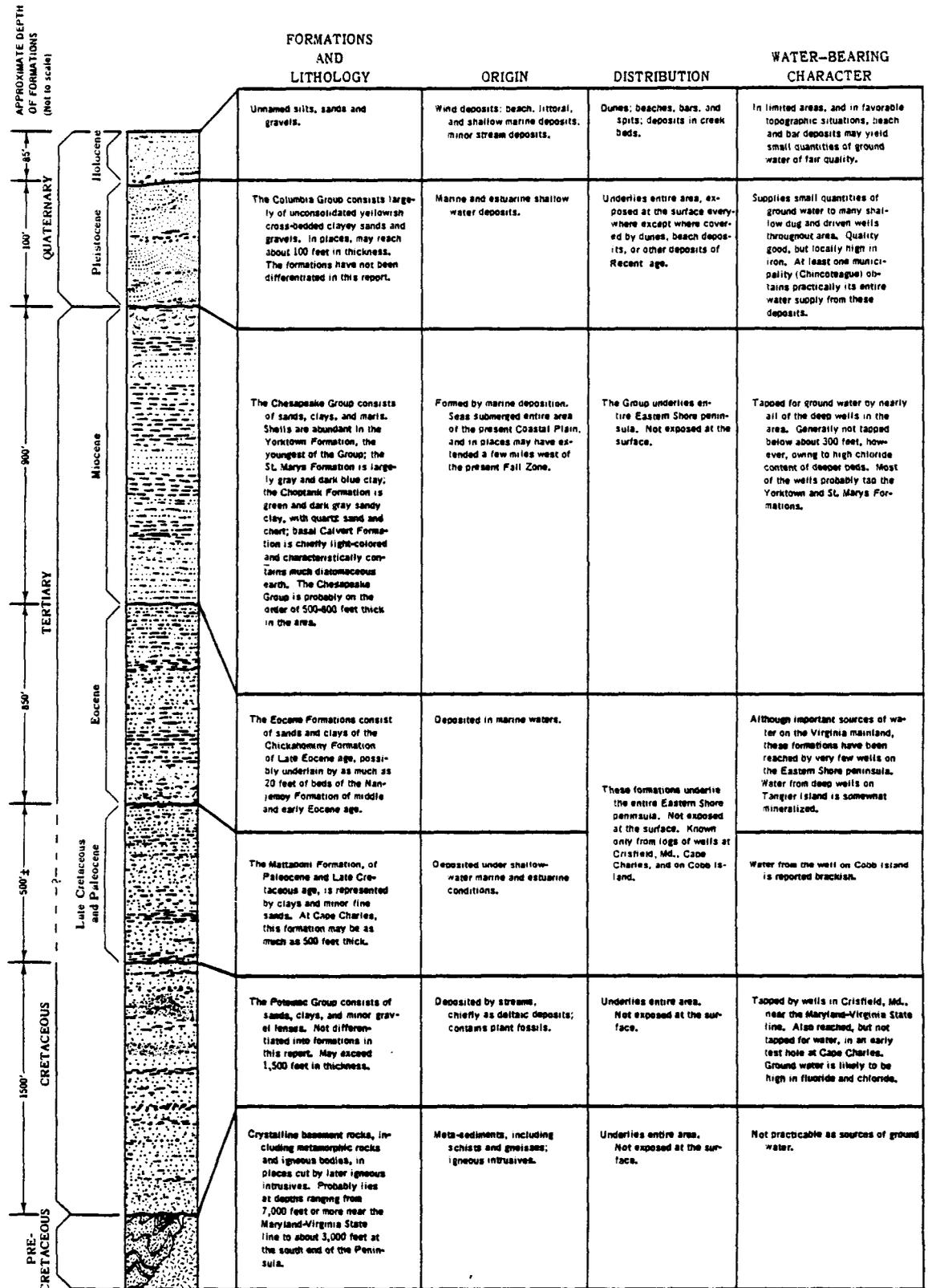


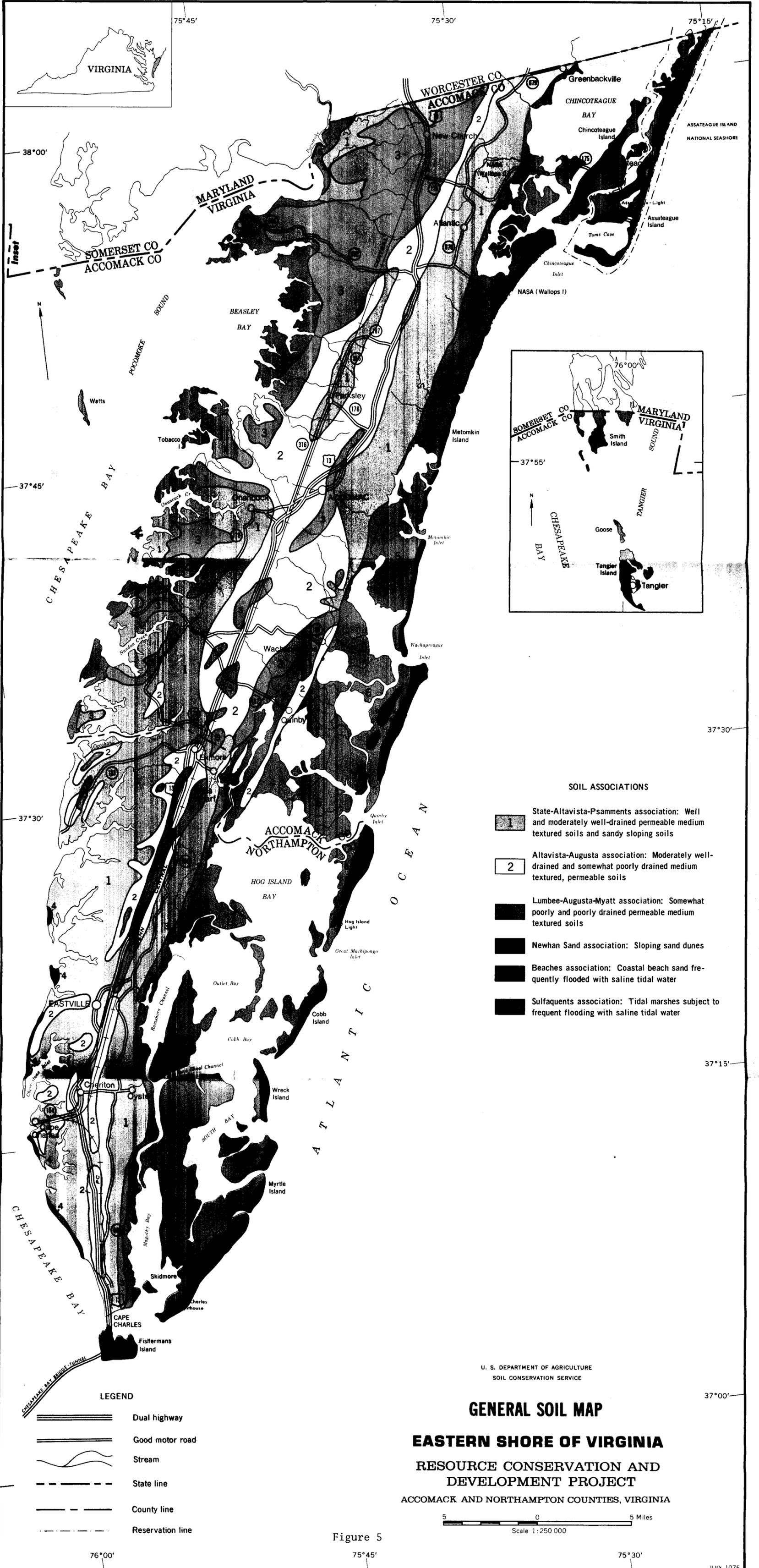
Figure 3

GEOLOGIC COLUMNAR PROFILE



SOURCE: COMMONWEALTH OF VIRGINIA DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT, DIVISION OF MINERAL RESOURCES

Figure 4



SOIL ASSOCIATIONS

- 1** State-Altavista-Psammets association: Well and moderately well-drained permeable medium textured soils and sandy sloping soils
- 2** Altavista-Augusta association: Moderately well-drained and somewhat poorly drained medium textured, permeable soils
- 3** Lumbee-Augusta-Myatt association: Somewhat poorly and poorly drained permeable medium textured soils
- 4** Newhan Sand association: Sloping sand dunes
- 5** Beaches association: Coastal beach sand frequently flooded with saline tidal water
- 6** Sulfaquents association: Tidal marshes subject to frequent flooding with saline tidal water

LEGEND

- Dual highway
- Good motor road
- Stream
- State line
- County line
- Reservation line

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

GENERAL SOIL MAP

EASTERN SHORE OF VIRGINIA

RESOURCE CONSERVATION AND DEVELOPMENT PROJECT

ACCOMACK AND NORTHAMPTON COUNTIES, VIRGINIA

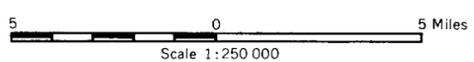


Figure 5

6. BIOTIC RESOURCES

a. General

The WFC area of 6,612 acres includes 3,950 acres of woodland brush and 1,140 acres of tidal marsh. This natural environment contains many types of botanical and animal life. The tidal marshes are covered with a variety of grasses which provide the spawning ground and home for marine life, waterfowl and shore birds, and other animals.

There are 40 species of saltwater fish in the area of Wallops, of which the most important are the puffer, gray trout, flounder, drum, croaker, butterfish, striped bass, and mackerel. Shellfish, one of the most important assets of the Eastern Shore, include oysters, hard and surf clams, scallops, crabs, and conch. Marine life ranges from the marine zoo-plankton to large marine mammals.

Small game species of the uplands are numerous - bobwhite quail, mourning dove, rabbit, gray squirrel, woodcock, and snipe. The only big game species found in Accomack County is the white tailed deer, except for the growing number of sika deer in the Chincoteague National Wildlife Refuge. The tidal marshes and beaches also support an abundance of birds, such as a variety of rails, sandpipers, and plovers, and many species of water and wading birds. (A more complete listing of the flora and fauna is to be found in Appendix A).

b. Endangered Species

The U. S. Department of the Interior maintains and issues the official list of endangered or threatened species of flora and fauna on a world-wide basis. The listings are subject to continual revision as the status of certain species change and new species are proposed.

Among the endangered or threatened species in the WFC area are:

Birds

Endangered (both U. S. and Virginia) - Peregrine falcon and osprey.

Threatened (Virginia) - Sharp shinned hawk, American kestrel, piping plover, gull-billed tern, and least tern.

Special Concern (Virginia) - Cattle egret, great blue heron, little blue heron, black-crowned night heron, Forster's tern, and royal tern.

Undetermined Status (Virginia) - American bittern and glossy ibis.

American Blue List (Early warning list published annually by the Audubon Society). - American bittern, yellow-breasted chat, cormorant, yellow-billed cuckoo, sharp-shinned hawk, black-crowned night heron, American kestrel, merlin, osprey, piping plover, purple martin, gull-billed tern, common tern, least tern, black tern, and yellow warbler.

Mammals

The only endangered mammal is the Delmarva Peninsula fox squirrel. Efforts which have been successful to date are under way to establish this species in the nearby Chincoteague National Wildlife Refuge.

Reptiles and Amphibians

The only species of concern are the Atlantic sea turtles - green, hawksbill, Ridley, and leatherback - which could appear on Wallops Island. All are federally protected as either threatened or endangered.

Fish

Fish which are important for recreation and commercial use are striped bass, black seabass, bluefish, cobia, Atlantic croaker, black drum, red drum, summer flounder, Southern kingfish, Northern kingfish, scup, spot, and weakfish.

Flora

Endangered - Pinweed, bog rush (*Juncus caeseriensis*), trillium, whorled pogonia, panic grass, and water hysop.

Threatened - Hog fennel, seaside alder, bog rush (*Juncus griscomii*), basil, and fringed orchis.

c. Wetlands and Floodplains

In the past it was generally known that marshes are an important habitat and food source for waterfowl. But until recently such wetland resources had been steadily shrinking because they were considered of use only for agriculture, commercial and recreational uses, and waste disposal. Only in recent years, however, has it been determined definitely that the coastal marsh is a vital source of organic material for the adjacent estuaries.

About one half of the plant material produced by a salt marsh is flushed into the estuary. The stems and leaves eventually fragment into tiny particles (detritus) through decay by the action of bacteria and fungi. Small crustaceans feed upon the bacteria and fungi, and juvenile fish consume the crustaceans in large numbers. Crabs, oysters, and clams consume the organic material directly. Estimates show that two-thirds of the value of the yearly commercial catch of fish and shellfish on the American East Coast come from species that spend at least a portion of their life cycle in the estuarine system where detritus of marsh origin is an important food source.

A coastal marsh is a herbaceous (plants lacking woody stems) plant community found on the part of the shoreline which is periodically flooded by salt or brackish water.

Vegetation of East Coast marshes is remarkably uniform. The intertidal zone from New England to Texas is dominated by a single species - smooth cordgrass (*Spartina alterniflora*). Two grasses - saltmeadow cordgrass (*Spartina patens*) and saltgrass (*Distichlis spicata*) - usually dominate the zone above high tide along the coast.

Salt marshes are valued as the source of primary production and as a nursery ground for sport and commercial fish species. They stabilize and protect shorelines, provide turbidity controls and a damping effect on storm surges, and store and recycle nutrients and pollutants, such as nitrogen, phosphorus, and heavy metals.

In 1972, the Virginia Wetlands Act was passed, requiring a permit before any activity is undertaken which may affect tidal wetlands. As a result of this landmark legislation, the amount of wetland destruction in Virginia dropped from an anticipated loss of 400 acres a year to less than 20 acres a year since 1972. The Virginia Wetlands Act stated that "the public policy of this Commonwealth (is) to preserve the wetlands and to prevent their despoliation and destruction and to accommodate necessary economic development in a manner consistent with wetlands preservation."

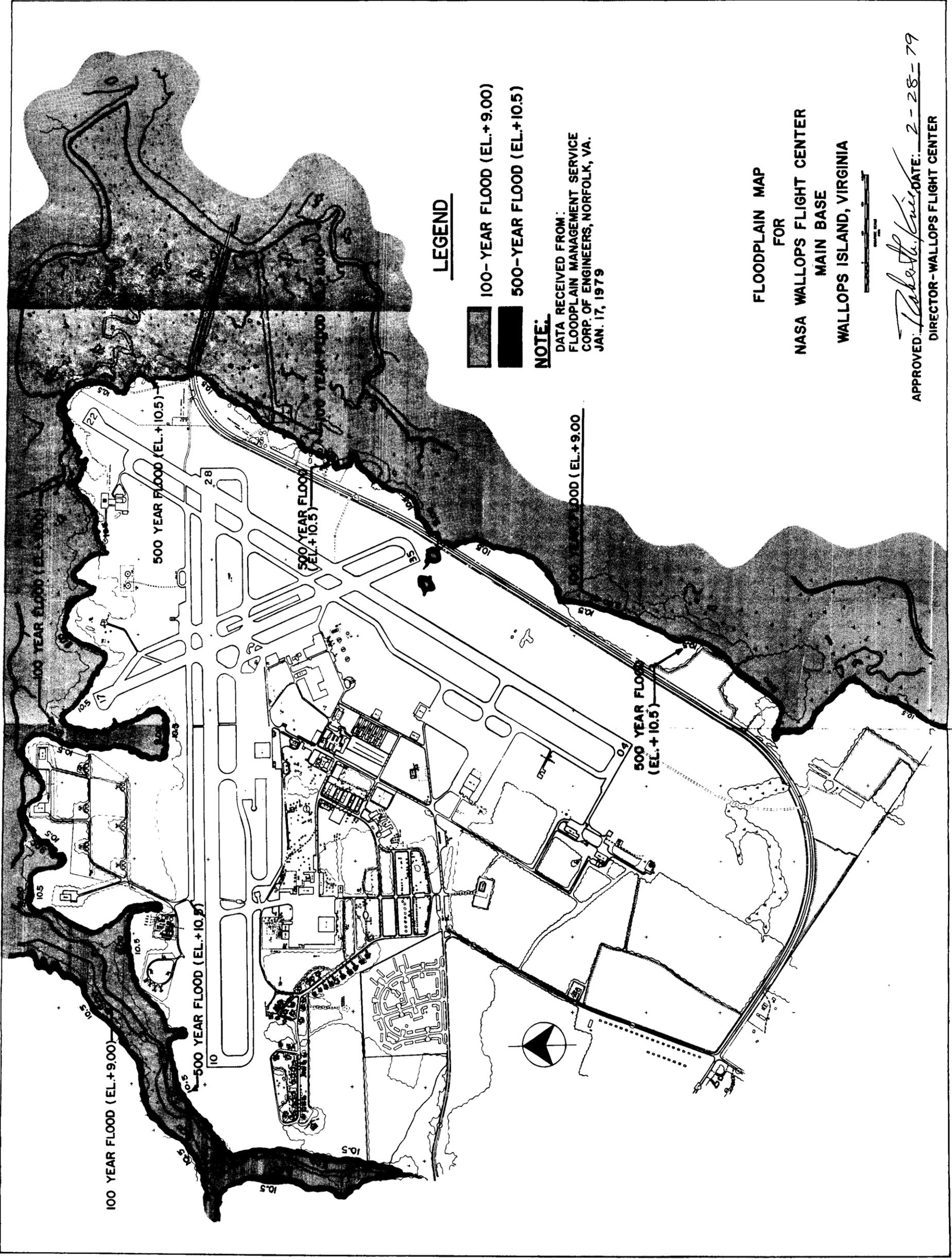
Accomack County, with 76,000 acres of salt and brackish water marshes - more than any other Virginia county - enacted a wetlands ordinance which prescribes the permitted activities and uses in wetlands. These include construction and maintenance of docks, fences, duckblinds and similar structures, the cultivation and harvesting of shellfish, noncommercial outdoor recreational activities, agriculture, conservation, navigation, and road maintenance.

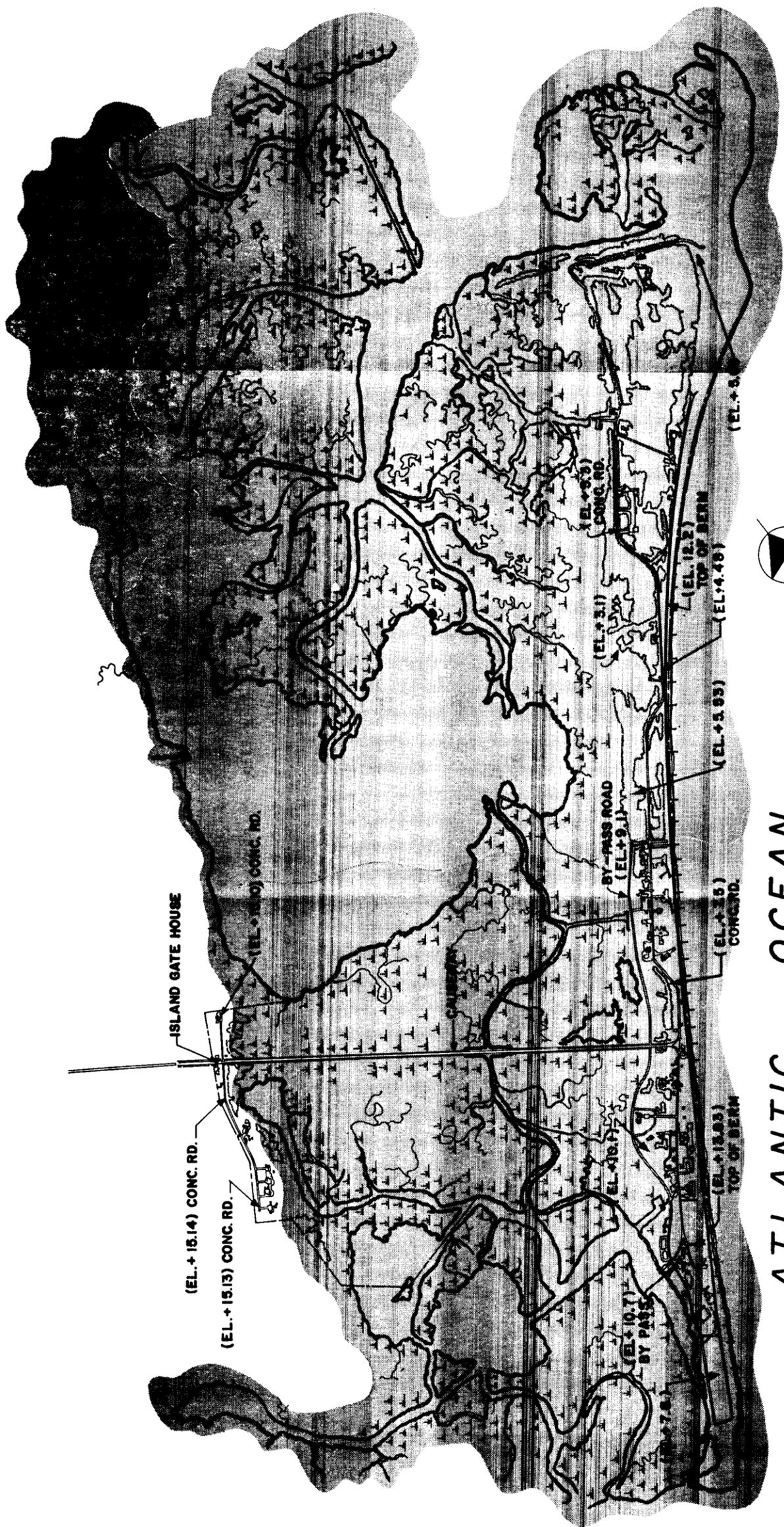
A tidal marsh inventory by the Virginia Institute of Marine Sciences in 1977 showed that Accomack County's marshland was nearly two-thirds in cordgrass - the grass with the highest priority for preservation in Virginia. Another 11 percent is in the second priority group for preservation.

Because of their ecological importance, wetlands now are under state and federal protection. The Department of the Interior recently designated Wallops Island as a National Natural Landmark.

The Nature Conservancy, a private nonprofit corporation, has acquired 12 barrier islands south of Wallops Island. This is called the Virginia Coast Reserve and contains about 35,000 acres. The state of Virginia is currently preparing legislation to impose more stringent standards for the preservation of the state's beachlands and dunes. Several public hearings have been held around the state, and legislation is expected to be introduced soon.

Attempts by WFC to stabilize the ocean shoreline on Wallops Island by the addition of groins and construction of a sea wall have succeeded partially in stabilizing the natural processes of erosion and accretion. The Island had a historical erosion rate of about seven feet per year until the sea wall was built. (See Figures 6 and 7).





ATLANTIC OCEAN

FLOODPLAIN MAP FOR

NASA WALLOPS FLIGHT CENTER
 WALLOPS ISLAND

WALLOPS ISLAND, VIRGINIA.

LEGEND

- AREAS FLOODED DURING 100 YEAR FLOOD (EL.+9.00)
- AND 500 YEAR FLOOD (EL.+10.5)

NOTE:
 DATA RECEIVED FROM:
 FLOODPLAIN MANAGEMENT SERVICE
 CORP. OF ENGINEERS, NORFOLK, VA.
 JAN. 17, 1979

APPROVED: *Robert H. Klein* DATE: 2-28-79
 DIRECTOR - WALLOPS FLIGHT CENTER

Figure 7

Repairs to eroded terrain, grading, and replanting are performed regularly at WFC through a grounds maintenance contract. The construction of the sea wall parallel to the shoreline at the Island was a major attempt to cope with a problem which has existed since the launch range on the Island was formed.

Wallops Island beach protection goes back to 1948 when NACA built protection for Launch Area #2. Other facilities were constructed in 1958 and 1961. A winter storm in 1962-1963 resulted in the loss of 100 to 150 feet of beach at the southern tip of the Island. Since then various protection projects have been completed.

The existing sea wall is covered with a sloping berm to contain storm tides and provide a natural beach contour. Groins on the bulkheads extend at right angles to the sea wall into the surf to trap and deposit material from the littoral drift thereby replacing sand lost during storm tides. Sand fences were also installed behind the sea wall to build up the foredunes, and deep rooting and matting grasses were planted to stabilize the beach front. In addition to its normal concern for its own property and facilities, WFC actively has assisted others in their efforts to preserve the shoreline. Wallops secured and evaluated low altitude (1,000 to 5,000 feet) imagery for the Virginia Institute of Marine Sciences in its studies of shorelines processes and in mapping wetland vegetation and waterway distribution.

7. SOLID WASTE GENERATION, TREATMENT, DISPOSAL

The WFC sanitary sewage treatment plant processes approximately 130,000 gallons per day. The plant has dual facilities, each capable of processing twice the present load. Each system consists of a communitor, primary sedimentation tank, trickling filter, final sedimentation tank, chlorine contact tank, unheated sludge digester, and sludge drying beds. The plant is capable of full gravity operation in case of power failure.

The launch range on Wallops Island has a lagoon and polishing pond capable of processing 30,000 gallons of waste per day. It operates at approximately one-third of capacity. Outlying facilities at Wallops use state inspected septic tanks and drainfields for waste disposal. The waste disposal facilities are operated under regulations and guidelines of the state and federal agencies. Effluents are regularly tested, and the results all have been well under the state and federal limits for biological oxygen demand (BOD), dissolved oxygen, coliform bacteria, total suspended solids (TSS), and pH factor. (Section 4b shows the results).

WFC also processes approximately 10,000 cubic yards of noncompacted trash annually. Closed collection containers are unloaded at a landfill site situated at a remote fenced area adjoining the Wallops property. The site, operated by Accomack County, originally had 59 usable acres of which 38 acres remain. The site is being filled at a rate of about 7 acres per year.

8. HAZARDOUS AND RADIOACTIVE SUBSTANCES

a. Toxic Chemicals

- (1) Vinyl Chloride - This is used in plastics for various test purposes. Its use is confined to standard, approved, self-contained hoods with fumes diluted to below federal standards.
- (2) Asbestos - Asbestos exposure at Wallops is from materials used in past construction or the machining of rocket nose cones. The use of asbestos in construction is no longer permitted, and engineering controls have been incorporated into the machining process to eliminate the exposure during these operations.

A complete survey was made at WFC to determine the locations of asbestos-containing materials and installations.

When asbestos-containing material is removed, it is done following the procedures set forth by OSHA 1910.1001 and EPA Title 40, Part 61, Subparts A and B. Removed asbestos materials are stored under lock and key with rigid controls until such time as they are removed from the Center to approved sites.

- (3) PCB's (Polychlorinated Biphenyls) - A continuous survey of known PCB containers (primarily transformers) is made, and all units are checked for leaks and discharges. If the leak or discharge is minor, repairs are made; when repairs are not practical, the leaking or discharging unit is stored under lock and key until it can be removed from WFC. Transformers and other devices are checked regularly for any possible defects. In the removal of asbestos-containing materials or damaged PCB containers, involved personnel use approved protective equipment.
- (4) Beryllium, Mercury - These chemicals are no longer used at WFC.

b. Pesticides

The following pesticides were used in 1979 at Wallops and are generally used each year:

Chlordane 72 percent - Approximately 300 gallons of a mixture of two quarts to a gallon of water were applied by hose and tank for termite control. The mixture is not stored nor is there any excess for disposal.

Diazinon 4E - Approximately 136 gallons of a mixture of a half ounce to a gallon of water is applied by spray for roaches. There is no storage or disposal of this mixture.

Dursban 2E - Approximately 16 gallons of a mixture of 1½ ounces to a gallon of water were applied by spray for roaches. There is no storage or disposal of this mixture.

Rozal anti-coagulant .05 percent - 89 pounds of a mixture of a pound of Rozal to 19 pounds of sweet stock were placed in containers for rodents. There is no storage or disposal of the mixture.

Hyvar X-L - 9,600 gallons of a mixture of a gallon of Hyvar to 160 gallons of water and a gallon of that mixture with two pounds of Bromacil were sprayed on weeds. Four gallons were stored on a wooden pallet on a concrete floor.

Sevin Powder 50-W - 2,000 gallons of a mixture of 1½ pounds to 100 gallons of water (EPA Reg. #1016-41) were used for beetles and bagworms. 20 pounds were stored on a wooden pallet on a concrete floor.

Calcium Chloride - 239 cubic yards of a mixture of 50 pounds per cubic yard of sand were used for snow and ice removal; 4,200 pounds were stored in a wooden pallet on a concrete floor in the back of a shop.

c. Radioactive Material, Non-Ionizing Radiation

WFC has a radioactive source license (#45-08886-02) issued by the U. S. Nuclear Regulatory Commission. The license authorizes WFC to have a total of 11,000 curies of Cobalt 60, each source not to exceed 4,400 curies. This material is used for industrial radiography, and its use and handling at all times complies with federal regulations. All other radioactive materials used at Wallops are provided by range users. Such users must submit appropriate documentation on the use, recovery, and environmental impact of the material, as well as their NRC license and DOD approval. They must also provide a complete description of the procedures to be followed.

The population to be exposed to radioactive materials is limited to approved Wallops and/or range user personnel, and the number of such personnel working regularly with this material is limited to a maximum of eight.

X-Rays - There are two small industrial x-rays at Wallops which employ the same protective devices as are used in the handling of Cobalt 60. Exposure to the x-rays is minimal and also is limited to a maximum of eight people. There also is a Westinghouse medical x-ray unit used by Health Services with a maximum of two people working regularly with it and being exposed under approved medical procedures. The unit is used only for diagnostic reasons or for new employees.

Lasers - Currently there is only one permanent laser installation at the Center - the FPS 16 Runway Laser Tracking System located on the FPS-16 radar of the Wallops airport.

A Safety Analysis Report on this unit is on file and documents the hazards associated with high-powered laser systems such as this Class IV unit. Personnel are protected from hazardous ionizing radiation exposure by elevation and azimuth radiation limits, laser beam power attenuation for potentially hazardous areas, and power interrupt systems.

At any given time, there may be as many as 5 to 10 laser system programs being conducted at Wallops. These laser systems may, and do, vary in classification from Class I (non-hazardous radiation) to Class IV. In each case, the laser system is reviewed by Wallops safety personnel, and operating requirements and restrictions are imposed according to classification and associated hazards to ensure against inadvertent exposure of personnel.

Radar Systems - Wallops has several high-powered radar systems. Most are permanently located on Wallops Island and at the Main Base, but some are also located in mobile vans which may be situated at Wallops or used for off-range programs as needed. These radar systems operate in a frequency spectrum of from 420 MHz up to 17,000 MHz, depending on the classification of each radar system. The operating frequency spectrum and maximum output power primarily determine the maximum tracking range of a radar system. The maximum personnel exposure criteria for any radar system or combination of radar systems is 10 milliwatts per square centimeter per hour, regardless of the operating frequency or output power. This exposure limit criteria is accomplished by locating the radar(s) at remote sites with population controls, such as fences, etc., and power attenuation or power shutdown for designated areas hazardous to personnel.

The following table lists the Wallops radar systems, their operating frequency range, maximum output power, and location:

<u>RADAR</u>	<u>FREQUENCY RANGE</u> (megahertz)	<u>PEAK POWER OUTPUT</u>	<u>LOCATION</u>
AN/FPQ-6	5400-5900	3 megawatts	Mainland, behind Island
AN/FPS-16	5400-5900	1 megawatt	Island
AN/MPS-19	2700-2900	325 kilowatts	Island
Pathfinder	9330-9420	40 kilowatts	Island
SPANDAR	2700-2900	5 megawatts	Mainland, behind Island
RARF	420-450	8 megawatts	Mainland, behind Island
RARF	2700-2900	5 megawatts	Mainland, behind Island
RARF	9280	1 megawatt	Mainland, behind Island
AN/ASR-7	2700-2900	425 kilowatts	Main Base, N-159
AN/FPS-16V	5450-5825	1 megawatt	Wallops Airport Runway
ASR-9437	16000-17000	140 kilowatts	NASA 428 Aircraft
Radar 10	2700-2900	325 kilowatts	Mobile Van
Radar 11	2700-2900	325 kilowatts	Mobile Van
Radar 17	2700-2900	325 kilowatts	Mobile Van

9. NOISE, SONIC BOOM, VIBRATION

WFC operations include rocket launchings, balloon launchings, aircraft and drone operations, chaff releases, large and small caliber gun firings, barge targets, and the use of lasers and radars.

Sounding rocket launches reached a maximum of 575 in 1974, but in 1978 had dropped to 292. Balloon launchings totaled 120 for 1977 and 1978. The number of aircraft take-offs and landings range from 2,000 to 3,000 per year.

All facilities that are potential noise areas - environmental laboratories, machine shops, etc. - have undergone noise level measurements, and in no cases did any of them exceed the levels prescribed by OSHA. The 24-hour average ambient noise level at WFC is appreciably lower than the EPA recommended upper level of 70 db. This is on a scale ranging from approximately 10 db for the rustling of grass or leaves to 115 db, the unprotected hearing upper limit for exposure on a missile or space launch.

Wallops does not conduct any tests which involve sonic booms. Aircraft tests by range users at WFC that may create sonic booms must provide an environmental assessment which must be approved by the appropriate Wallops official(s). Operating envelopes (factors) are established to assure that the sonic boom will not create a personnel noise hazard or result in property damage.

Rocket launches at WFC are of short duration, and everyone in the immediate vicinity is under cover. Appropriate ear protection is required and provided for any operations where noise exposure could be a hazard such as refueling operations involving aircraft with engines running. Flight patterns of research aircraft are directed so as to reduce noise effects on local communities.

10. ECONOMIC, CULTURAL FACTORS

a. Schools

Accomack County has eight public elementary schools, one junior high, four senior high schools, and two combined schools, with 172 elementary and 149 secondary teachers for 6,332 students.

The Marine Science Consortium, located adjacent to Wallops in former WFC residences, conducts various marine science courses during the year, and its personnel and pupils sometimes use the northern portion of Wallops Island for field trips.

There are four colleges within a 50 mile radius of the Wallops Center:

- (1) The Eastern Shore Community College at Melfa, Virginia, is part of the Virginia Community College System. The two-year college is designed to accommodate 600 students, and its enrollment has been averaging about 500, with half the students on a full-time basis.

- (2) Salisbury State College in Salisbury, Maryland, is part of Maryland's higher education system and has an enrollment of about 2,500 in its four year courses.
- (3) University of Maryland Eastern Shore at Princess Anne, Maryland, part of the University of Maryland system, is a four-year institution with an enrollment of about 800.
- (4) Wor-Wic Tech Community College at Salisbury, Maryland, is a two-year (Associate Degree) institution with an average enrollment of 600 students in the College Credit Program (400 part-time and 200 full-time students), and an average of 2,000 students in the Community Education Program.

b. Medical Facilities

There are two fully equipped hospitals serving the Wallops area - the Peninsula General Hospital Medical Center in Salisbury, Maryland, and the Northampton Accomack Memorial Hospital in Nassawadox, Virginia, both approximately 40 miles from WFC.

There are also medical facilities both at the Main Base and on the Island to provide examinations, first-aid, and emergency services. The occupational health facility at the Main Base has two full-time registered nurses, a physician on contract to provide service when needed, a part-time lab technician, 33 registered Emergency Medical Technicians (Ambulance), and two ambulances - advanced life support units. The Main Base facility provides routine physical examinations and some special examinations such as for asbestos workers and radiographers.

c. Recreation

Recreational facilities in the area include the public beach on Assateague Island; the 9,039 acre Chincoteague National Wildlife Refuge which was established in 1943 and in 1955 became part of the Assateague Island National Seashore; public boat ramps in the Chincoteague/Atlantic areas; nine major campgrounds in the Chincoteague/Assateague area, and 20 motels and tourist homes in Chincoteague. The county recently acquired land at Wallops Island which has been developed into a park, including nature trails, picnic sites, and nature experience areas.

d. Population

The 1970 population of Accomack County was 29,004, and it has been declining since 1930. However, a small increase is likely in the 1980 census. A 1975 estimate put the population at 30,760. The 1970 population breakdown showed 18,150 whites (8,671 men; 9,479 women) and 10,854 blacks (5,195 men; 5,659 women).

The civilian work force in Accomack County was estimated at 17,363 in March 1978, with about 1,500 unemployed. The per capita income in the county was \$3,354, compared with \$3,918 for the state.

WFC is near a rich agricultural area which is rather sparsely populated. The main industries of the area are truck farming (potatoes, soy beans, etc.), poultry raising, commercial fishing, and tourism.

The area is considered a labor surplus area. The largest employers are WFC, which has approximately 400 federal employees and 375 contract employees, and two poultry processing firms (Perdue at Accomack with 1,140 employees; Holly Farms at Temperanceville with 980).

The average wages and salaries of the employed Accomack labor force are generally lower than those of the entire state labor force (\$153 as against \$217 per week), according to the Virginia Employment Commission.

The following figures from the Virginia Employment Commission show a breakdown in the average weekly rate:

	<u>Accomack Co.</u>	<u>State</u>
Agriculture, forestry, fisheries	\$189	\$156
Construction	203	243
Manufacturing	147	245
Transportation, utilities	298	304
Trades	126	176
Finance, insurance, real estate	186	221
Services	148	193

Chincoteague is the largest community in Accomack County, with a population of 1,867 in 1970. During the summer months, the population grows considerably with the influx of vacationers and tourists. The island on which the city is located is seven miles long and one and one-half miles wide - the largest inhabited island in the state.

e. Police, Fire Protection

WFC maintains a continuous program with a security force of 18 men to provide personnel identification and entry authorization, clearance of hazardous areas during launch and landing operations, vehicular traffic control, control of secured areas, classified document storage responsibility, and surveillance to prevent theft and destruction of government property.

The Main Base has a fire station located adjacent to the airfield, with direct access to all areas of the base. There are seven fire fighting vehicles and one fully equipped ambulance available to be dispatched to all areas. Existing developed areas and facilities are adequately served by strategically located fire hydrants. There are also special flush type hydrants located around the airfield parking aprons. There is a fire station on the Island, located just south of the Causeway terminus and convenient to all areas. This station has two fire pumper engines and one ambulance. Two types of fire alarm systems are used. The telephone alarm is used in the operational and airfield areas; automatic alarms

are used in the rocket storage area and computer section. In addition, a 24-hour roving patrol provides early detection of fire violations and hazards. An abundance of portable fire extinguishers are located throughout all buildings and storage areas.

f. Transportation

The only commercial air terminal is the Salisbury-Wicomico County Airport, near Salisbury, Maryland, which is served by the Allegheny Commuter service to Washington, DC; Baltimore, Maryland; and Philadelphia, Pennsylvania.

Accomack County owns and operates an airport at Melfa, with a 5,000-foot runway, and there are nine registered private landing areas in the county.

The Wallops airfield has three runways - 8,750 feet, 8,000 feet, and 4,820 feet - two hangars for NASA owned or operated aircraft, and office and shop space for approved aircraft projects. The airfield also has permanent experimental facilities for:

- (1) Runway research to test the effectiveness of pavement grooving for take-off and landing.
- (2) Experimental wind data system designed to collect and process wind velocity, direction, and temperature from sensors mounted on a portable, retractable 50-foot tower.
- (3) Aeronautical research radar complex with an integrated radar/computer instrumentation program, and precision rocket or satellite tracking.
- (4) Airport project control center.

Commercial bus service is provided by the Greyhound and Carolina Trailways lines, operating north and south on U. S. 13. The nearest terminal is located at "T's Corner," at the intersection of U. S. 13 and Va 175, four miles west of the Main Base.

Railroad service, freight only, is provided by the Virginia and Maryland Railroad, which runs roughly parallel to U. S. 13 from the southern end of the Peninsula to Wilmington, Delaware. The nearest freight depot is at Lecato, Virginia, seven miles from the Main Base.

Vehicular traffic to and from Wallops is by way of Va 175, which runs from U. S. 13 at "T's Corner" to Chincoteague. U. S. 13 runs the entire length of the Peninsula and provides ready access to major cities to the north and south.

APPENDIX A

BIRDS (Common and Abundant)

Avocet, American (*Recurvirostra americana*)
Bittern, American (*Botaurus lentiginosus*)
Blackbird, red-winged (*Agelaius phoeniceus*)
Bluejay (*Cyanocitta cristata*)
Bobwhite (*Colinus virginianus*)
Bunting, indigo (*Passerina cyanea*)
Cardinal (*Cardinalis cardinalis*)
Catbird, gray (*Dumatella carolinensis*)
Chat, yellow-breasted (*Icteria virens*)
Chickadee, Carolina (*Parus carolinensis*)
Coot, American (*Fulica americana*)
Cormorant, double-crested (*Phalacrocorax auritus*)
Cowbird, brown-headed (*Molothrus ater*)
Creeper, brown (*Certhia familiaris*)
Crow:
 Common (*Corvus brachyrhynchos*)
 Fish (*Corvus ossifragus*)
Cuckoo, yellow-billed (*Coccyzus americanus*)
Dove, mourning (*Zenaida macroura*)
Duck:
 American wigeon (*Anas americana*)
 Black (*Anas subripes*)
 Blue-winged teal (*Anas discors*)
 Bufflehead (*Bucephala albeola*)
 Common or black scoter (*Melanitta nigra*)
 Gadwall (*Anas strepera*)
 Green-winged teal (*Anas crecca*)
 Mallard (*Anas platyrhynchos*)
 Merganser, red-breasted (*Mergus serrator*)

Northern shoveler (*Anas clypeata*)
Old squaw (*Clangula hyemalis*)
Pintail (*Anas acuta*)
Ruddy (*Oxyura jamaicensis*)
Surf scoter (*Melanitta perspicillata*)
White-winged scoter (*Melanitta deglandi*)

Egret:

Cattle (*Bubulcus ibis*)
Great (*Casmerodius albus*)
Snowy (*Egretta thula*)

Falcon, peregrine (*Falco peregrinus*)

Finch, purple (*Carpodacus purpureus*)

Flycatcher, great crested (*Myiarchus crinitus*)

Gallinule, common (*Gallinula chloropus*)

Gannet (*Morus bassanus*)

Gnatcatcher, blue-gray (*Polioptila caerulea*)

Goldfinch, American (*Carduelis tristis*)

Goose:

Brant (*Branta bernida*)
Canada (*Branta canadensis*)
Snow (*Chen caeruvescens*)

Grackle:

Boat-tailed (*Quiscalus major*)
Common (*Quiscalus quiscula*)

Grebe:

Horned (*Podiceps suritus*)
Pied-billed (*Podilymbus podiceps*)

Grosbeak:

Evening (*Hesperiphona vespertina*)
Rose-breasted (*Pheucticus ludovicianus*)

Gull:

Bonaparte's (*Larus philadelphia*)
Great black-backed (*Larus marinus*)
Herring (*Larus argentatus*)
Laughing (*Larus atricilla*)
Ring-billed (*Larus delawarensis*)

Hawk:

Marsh (*Circus cyaneus*)
Red-tailed (*Buteo jamaicensis*)
Sharp-shinned (*Accipiter striatus*)

Heron:

Black-crowned night (*Nycticorax nycticorax*)
Great blue (*Ardea herodias*)
Green (*Butorides striatus*)
Little blue (*Florida caerulea*)
Louisiana (*Hydranassa tricolor*)

Humming-bird, ruby-throated (*Archilocus colubris*)

Ibis, glossy (*Plegadis falcinellus*)

Junco, dark-eyed (*Junco hyemalis*)

Kestrel, American (*Falco sparverius*)

Killdeer (*Charadrius vociferus*)

Kingbird, Eastern (*Tyrannus tyrannus*)

Kingfisher, belted (*Megaceryte alcyon*)

Kinglet:

Golden-crowned (*Regulus satrapa*)
Ruby-crowned (*Regulus calendula*)

Lark, horned (*Eremophila alpestris*)

Loon:

Common (*Gavia immer*)
Red-throated (*Gavia stellata*)

Meadowlark, Eastern (*Sturnella magna*)

Merlin (*Falco columbarius*)

Mockingbird (*Mimum polyglottos*)

Nuthatch, red-breasted (*Sitta canadensis*)

Oriole:

Northern (*Icterus galbula*)
Orchard (*Icterus spurius*)

Osprey (*Pandion haliaetus*)

Owl:

Great horned (*Bubo virginianus*)
Screech (*Otus asio*)

Oystercatcher, American (*Haematopus palliatus*)

Pewee, Eastern wood (*Contopus virens*)

Phalarope, Northern (*Lobipes lobatus*)

Phoebe, Eastern (*Sayornis phoebe*)

Plover:

Black-bellied (*Pluvialis squatarola*)

Piping (*Charadrius melodus*)

Semipalmated (*Charadrius semipalmatus*)

Wilson's (*Charadrius wilsonia*)

Purple martin (*Progne subis*)

Rail:

Clapper (*Rallus longirostris*)

Virginia (*Rallus limicola*)

Robin (*Turdus migratorius*)

Ruddy turnstone (*Arenaria interpres*)

Sandpiper:

Dunlin (*Calidris alpina*)

Greater yellowlegs (*Tringa melanoleuca*)

Least (*Calidris minutilla*)

Lesser yellowlegs (*Tringa flavipes*)

Long-billed dowitcher (*Limnodromus scolopaceus*)

Pectoral (*Calidris melanotos*)

Red knot (*Calidris canutus*)

Sanderling (*Calidris alba*)

Semipalmated (*Calidris pusilla*)

Short-billed dowitcher (*Limnodromus griseus*)

Solitary (*Tringa solitaria*)

Spotted (*Actitis macularia*)

Stilt (*Microfalana himantopus*)

Western (*Calidris mauri*)

White-rumped (*Calidris fuscicollis*)

Skimmer, black (*Rynchops niger*)

Snipe, common (*Capella gallinago*)

Sparrow:

Chipping (*Spizella passerina*)

Field (*Spizella pusilla*)

Savannah (*Passerculus sandwichensis*)

Seaside (*Ammospiza maritima*)

Sharp-tailed (*Ammospiza candacuta*)

Song (*Melospiza melodia*)

Swamp (*Melospiza georgiana*)

White-throated (*Zonotrichia albicollis*)

Starling (*Sturnus vulgaris*)

Stilt, black-necked (*Himantopus mexicanus*)

Swallow:

Bank (*Riparia riparia*)

Barn (*Hirundo rustica*)

Tree (*Iridoprocne bicolor*)

Swan, whistling (*Olar columbianus*)

Tanager, scarlet (*Piranga rubra*)

Tern:

Black (*Chlidonias niger*)

Caspian (*Sterna caspia*)

Common (*Sterna hirundo*)

Forster's (*Sterna forsteri*)

Gull-billed (*Gelochelidon nilotica*)

Least (*Sterna albifrons*)

Royal (*Sterna maxima*)

Thrasher, brown (*Toxostoma rufum*)

Thrush:

Hermit (*Catharus guttatus*)

Wood (*Hyllocichla mustelina*)

Townee, rufous-sided (*Pipilo erythrophthalmus*)

Vireo:

Red-eyed (*Vireo olivaceus*)

White-eyed (*Vireo griseus*)

Warbler:

Black and white (*Mniotilta varia*)

Black-throated blue (*Dendroica caerulescens*)

Cape May (*Dendroica tigrina*)

Hooded (*Wilsonia citrina*)

Magnolia (*Dendroica magnolia*)

Palm (*Dendroica palmarum*)

Pine (*Dendroica pinus*)

Prairie (*Dendroica discolor*)

Wilson's (*Wilsonia pusilla*)

Yellow (*Dendroica petechia*)

Yellow-rumped (*Dendroica coronata*)

Water thrush, Northern (*Seiurus noveboracensis*)

Waxwing, cedar (*Bombycilla cedrorum*)

Whimbrel (*Numenius americanus*)

Willet (*Calidris melanotos*)

Woodcock, American (*Philohela minor*)

Woodpecker:

Common Flicker (*Colaptes auratus*)

Downy (*Picoides pubescens*)

Wren:

Carolina (*Thryothorus ludovicianus*)

House (*Troglodytes aedon*)

Long-billed marsh (*Cistothorus palustris*)

Yellowthroat, common (*Geothlypis trichas*)

MAMMALS

Deer:

Sika (*Cervus nippon*)

White-tail (*Odocoileus virginianus*)

Dog, wild (*Canis familiaris*)

Fox, red (*Vulpes fulva*)

Meadow vole (*Microtus pennsylvanicus*)

Mouse:

House (*Mus musculus*)

Meadow jumping (*Zapus hudsonius*)

White-footed (*Peromyscus leucopus*)

Muskrat (*Ondatra zibethica*)

Opossum, Virginia (*Didelphis marsupialis*)

Rabbit, Eastern cottontail (*Sylvilagus floridanus*)

Raccoon (*Procyon lotor*)

Rat, rice (*Oryzomys palustris*)

Shrew:

Least (*Cryptotis parva*)

Short-tail (*Blarina brevicauda*)

REPTILES AND AMPHIBIANS

Snake:

Black rat (*Elaphe o. obsoleta*)

Eastern hognose (*Heterodon platyrhinos*)

Northern black racer (*Coluber c. constrictor*)

Southern hognose (*Heterodon simus*)

Toad:

Fowler's (Bufo woodhousei fowleri)
Green treefrog (Hyla cinerea)

Turtle:

Atlantic loggerhead (Caretta c. caretta)
Common snapping (Chelydra s. serpentina)

FLORA

Ash, black (Fraxinus nigra marsh)

Aster (Aster sp.)

Bayberry (Myrica pennsylvanica loisel)

Beachgrass (Ammophila breviligulata)

Blackberry or raspberry (Rubus sp.)

Black-eyed Susan (Rudbeckia serotina nutt.)

Butterfly weed (Asclepias tuberosa)

Camphor weed (Heterotheca subaxillaris)

Castor bean (Ricinus communis)

Cat-tail, common (Typha sp.)

Cedar, red (Juniperus virginiani)

Cherry, black (Prunus sp.)

Clover:

Rabbit-foot (Trifolium aervense)
White (Trifolium sp.)

Coneflower (Rudbeckia sp.)

Cosmos (Cosmos sp.)

Dandelion (Taraxacum sp.)

Daylily, Asiatic (Commelina communis)

Duckweed, lesser (Lemnaceae sp.)

Grape (Vitis sp.)

Grass:

American dunegrass (*Elymus arenarius*)
Crab (*Eleusine indica*)
Reed (*Phragmites communis trin.*)
Salt (*Distichlis spicata*)
Salt marshcord (*Spartina alterniflora loisel*)
Salt meadowgrass or hay (*Spartina patens*)

Greenbrier, common (*Smilax sp.*)

Groundsel (*Senecio sp.*)

Hempweed, climbing (*Mikania scandens*)

Honeysuckle, Japanese (*Lonicera japonica thumb.*)

Horsemint (*Monarda sp.*)

Jewel weed (*Impatiens carpensis meerb.*)

Maple:

Red (*Acer rubrum*)
Silver (*Acer saccharinum*)

Marsh elder (*Iva frutescens*)

Marsh/sea pink (*Sabatia stellaris pursh*)

Milkweed (*Asclepias sp.*)

Oak, willow (*Quercus phellos*)

Periwinkle (*Vinca sp.*)

Pine:

Loblolly (*Pinus taeda*)
Virginian or scrub (*Pinus virginiana mill.*)

Poison ivy (*Rhus radicans*)

Pokeweed (*Phytolacca americana*)

Princess tree (*Paulownia tomentosa*)

Privet (*Ligustrum tomentosa*)

Queen Anne's lace or wild carrot (*Daugus carota*)

Saltwort or glasswort (*Salicornia sp.*)

Sassafras (*Sassafras albidum*)

Sea myrtle (*Baccharis halmifolia*)

Sea rocket (*Cakile eduntula*)
Sneezeweed, purple-headed (*Helenium nudiflorum* Nutt.)
Sumac, dwarf (*Rhus* sp.)
Sweet gum (*Liquidambar styraciflua*)
Trumpet creeper (*Campsis radicans*)
Tulip-poplar (*Liriodendron tulipifera*)
Vetch, cow or tufted (*Vicia cracca*)
Weeping willow (*Salix babylonica*)

INVERTEBRATES

Angelwing (*Cyrtopleura costata*)
Angelwing, false (*Petricola pholadiformis*)

Ark:

Blood (*Anadara ovalis*)
Ponderous (*Noetia ponderosa*)

Clam:

Atlantic jackknife (*Ensis directus*)
Atlantic surf (*Spisula solidissima*)
Canneled duck (*Anatina plicatella*)

Comb jelly (*Mnemiopsis leidyi*)

Coquina, Florida (*Donax reomeri protracta*)

Coral, dwarf cup (*Astragalinia rathbuni*)

Crab:

Blue (*Callinectes sapidus*)
Flat mud (*Eurypanopeus depressus*)
Ghost or sand (*Ocypode quadrata*)
Hermit (*Pagurus longicarpus*, *P. pollicaris*)
Horseshoe (*Limulus polyphemus*)
Lady (*Ovalipes ocellatus*)
Mole or sand bug (*Emerita talpoida*)
Mud (*Panopeus herbstii*, *Rhithropanopeus harrisi*)
Mud fiddler (*Uca pugnax*)
Narrow mud (*Hexapanopeus angustifrons*)
Rock (*Cancer irroratus*)
Sand fiddler (*Uca pugilator*)
Spider (*Libinia emarginata*)
Spider or sea hag (*Libinia dubia*)

Jellyfish, lion's mane (*Cyanea capillata*)

Limpet, cayenne keyhole (*Diodora cayenensis*)

Mussell:

Atlantic ribbed (*Modiolus demissus*)

Common blue (*Mytilus edulis*)

Nassa:

Eastern mud (*Ilyanassa obsolata*)

New England (*Nassarius trivittatus*)

Oyster, Eastern (*Crassostrea virginica*)

Oyster drill, Atlantic (*Urosalpinx cineria*)

Periwinkle, marsh (*Littorina irrorata*)

Quahog, Northern (*Mercenaria mercenaria*)

Rock shell, Florida (*Thais haemastoma floridana*)

Sand dollar, Atlantic (*Echinerachnius parma*)

Scallop, Atlantic bay (*Aequipecten irradians*)

Single, Atlantic (*Anomia simplex*)

Slipper shell, common Atlantic (*Crepidula fornicata*)

Snail:

Atlantic moon (*Polinices duplicatus*)

Common baby's ear (*Sinum scopulosum*)

Mud (*Nassarius obsoletus*)

Northern moon (*Lunatia heros*)

Sponge, boring (*Cliona celata*)

Starfish, common or Eastern (*Asterias forbesi*)

Tagelus, stout (*Tagelus plebeius*)

Whelk:

Channeled (*Busycon carica*)

Knobbed (*Busycon canaliculatum*)

Worm:

Arrow (*Sagitta serratodentata*)

Blood (*Glycera dibranchiata*)

Polychaete (*Nereis succinea*)

Tube (*Dioptra cuprea*)

FISH (Reported in vicinity of Wallops Island)

Albacore (*Thunnus alalunga*)

Alewife (*Alosa pseudoharengus*)

Anchovy:

Bay (*Anchoa mitchilli*)

Striped (*Anchoa hepsetus*)

Bass:

Black seabass (*Centropristis striata*)

Striped (*Morone saxatilia*)

Bigeye, short (*Pristigenys alta*)

Blenny, striped (*Chasmodes bosouianus*)

Bluefish (*Pomatomus sallatrix*)

Bonito (*Sarda* spp.)

Burrfish, striped (*Chilomycterus schoepfi*)

Butterfish (*Peprilus triacanthus*)

Cobia (*Rachycentron canadum*)

Crevalle jack (*Caranx hippos*)

Croaker, Atlantic (*Micropogon undulatus*)

Cunner (*Tautoglabrus adspersus*)

Cusk-eel, striped (*Rissola marginata*)

Drum:

Black (*Pogonias cromis*)

Red (*Sciaenops ocellata*)

Eel:

American (*Anguilla rostrata*)

Conger (*Conger oceanicus*)

Filefish, planehead (*Monacanthus hispidus*)

Flounder:

Fringed (*Etropus crossotus*)

Small mouth (*Etropus microstomus*)

Summer (*Paralichthys dentatus*)

Windowpane (*Scophthalmus aquosus*)

Winter (*Pseudopleuronectes americanus*)

Gag (*Mycteroperca microlepis*)

Goatfish, red (*Mullus auratus*)

Goby:

Green (*Microgobius thalassinus*)

Naked (*Gobiosoma bosci*)

Seaboard (*Gobiosma ginsburgi*)

Goosefish (*Lophius americanus*)

Hake:

Red (*Urophycis chuss*)

Spotted (*Urophycis regius*)

Halfbeak (*Hyporamphus* sp.)

Herring:

Atlantic (*Clupea harengus harengus*)

Blueback (*Alosa aestivalis*)

Hogchoker (*Trinectes maculatus*)

Killifish:

Banded (*Fundulus diaphanus*)

Mummichog (*Fundulus heteroclitus*)

Rainwater (*Lucania parva*)

Sheepshead minnow (*Cyprinodon variegatus*)

Spotfin (*Fundulus luciae*)

Striped (*Fundulus majalis*)

Kingfish:

Northern (*Menticirrhus saxatilis*)

Southern (*Menticirrhus americanus*)

Ladyfish (*Elops saurus*)

Lizard fish, inshore (*Synodus foetens*)

Lookdown (*Selene vomer*)

Mackerel:

Atlantic (*Scomber scombrus*)

King (*Scomberomorus cavalla*)

Spanish (*Scomberomorus maculatas*)

Manta, Atlantic (*Manta birostris*)

Menhaden, Atlantic (*Brevoortia tyrannus*)

Mullet:

Striped (*Mugil cephalus*)

White (*Mugil curema*)

Needlefish, Atlantic (*Strongylura marina*)

Perch:

Silver (*Bairdiella chrysura*)
White (*Morone americana*)

Permit (*Trachinotus falcatus*)

Pigfish (*Orthopristis chrysoptera*)

Pipefish, Northern (*Syngnathus fuscus*)

Pollock (*Pollachius virens*)

Puffer:

Northern (*Spheroides maculatas*)
Smooth (*Lagocephalus maculatas*)

Sand tiger (*Odontaspis taurus*)

Sculpin, longhorn (*Myoxcephalus octodecemspinesus*)

Scup (*Stenotomus chrysops*)

Seahorse, lined (*Hippocampus erectus*)

Searobin:

Northern (*Prionotus carolinus*)
Striped (*Prionotus evolans*)

Sennet, Northern (*Sphyrna borealis*)

Shad:

American (*Alosa sapidissima*)
Hickory (*Alosa mediocris*)

Shark:

Atlantic angel (*Squatina dumerili*)
Lemon (*Negaprion brevirostris*)
Sandbar (*Carchrhinus milberti*)
Smooth dogfish (*Mustelis canis*)
Smooth hammerhead (*Sphyrna zygaena*)
Spiny dogfish (*Squalus acanthias*)
Thresher (*Alopias vulpinus*)
Tiger (*Galeocerdo cuvieri*)

Shark sucker (*Echeneis naucrates*)

Silverside:

Atlantic (*Menidia menidia*)
Rough (*Membras martinica*)
Tidewater (*Menidia beryllina*)

Skate, clearnose (*Raja eglanteria*)
Spot (*Leiostomus xanthurus*)
Squirrel Fish (*Holocentrus ascensionis*)
Stargazer, Northern (*Astroscopus guttatus*)
Stickleback:
 Four-spine (*Apeltes quadracus*)
 Three-spine (*Gastrosteus aculeatus*)
Stingray:
 Blunt nose (*Dasyatis sayi*)
 Cownose ray (*Rhinoptera bonasus*)
 Rough tail (*Dasyatis centroura*)
 Smooth butterfly (*Gymnura micrura*)
 Southern (*Dasyatis americana*)
 Spiny butterfly (*Gymnura altavela*)
Sturgeon (*Acipenser* spp.)
Tarpon (*Megalops atlantica*)
Tautog (*Tautoga onitis*)
Toadfish, oyster (*Opsanus tau*)
Tonguefish, black-cheek (*Symphurus plagiusa*)
Weakfish (*Cynoscion regalis*)

APPENDIX B

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